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and consequent higher temperature, can be given to the gas which has passed into the second receiver by the portions which subsequently enter it. This is due to the fact that he ignores the motion of translation which the entering gas possesses. A mass of gas in motion as a whole, will act on another mass of gas in the same way as a moving piston, namely, increase the velocity of the molecules which collide with it.

Detailed criticism of Mr. Fireman's paper will have to be suspended until its publication. The statements in the abstract are very vague, and the author certainly does not show how the molecules with slow velocities force their way back against the rushing stream, and congregate in the first receiver.

We sometimes find the statement in textbooks that a gas expanding under such conditions that no work is done experiences no cooling, for example, when expanding into an infinite vacuum. It appears questionable, however, whether a gas can expand without doing work. Leaving out of consideration the internal work, *i. e.*, the overcoming of the forces of cohesion, we still have the gas in the receiver doing work in giving a motion of translation to the mass of gas thrown out into the vacuum.

R. W. WOOD.

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BITTER ROT OF APPLES.

IN the article upon this subject in SCIENCE for October 24, 1902, page 669, there is no reference to similar investigations with like results previously published. There is, however, an intimation that earlier knowledge was insufficient to justify publication.

There is sent herewith a 'circular' and a 'bulletin' issued by the Agricultural Experiment Station of the University of Illinois, which were put into the mails on respectively the fourteenth and twenty-ninth days of July of this year. Of the first there were sent out 1,200, and of the second 20,000 copies. They have each been referred to or copied entire in at least one hundred different periodicals throughout the country. Copies were mailed direct on the days indicated to the author whose name is signed first to the article now in

question, and he may easily have first learned by this means of Mr. Simpson's discovery. At all events the publication of July 14 was in the possession of the general public before these special studies were begun in Illinois by the authors of this later paper.

Field studies made on July 11, 12 and 13 in orchards near Parkersburg, Olney, Clay City, Salem and Tonti, Illinois, by Professor J. C. Blair and myself, left no room for doubt that the early infection of the fruit was mainly from the limb cankers. These cankers were found, after we learned how to look for them, as sources of such infection in hundreds of instances with not five per cent. of failures. Then two hours with the compound microscope on the evening of July 12, at our laboratory at Salem, demonstrated beyond cavil the protrusion of the spores of this specific *Gleosporium* from the cankers. Such spores positively so produced were at this time inoculated into fresh apples, and the resultant spots, which showed on the 14th, were clearly identified as those of bitter rot on the 15th—three days after the inoculations—while check punctures remained sterile. These tests were often repeated during following days, with the same results.

This disease of the apple has annually caused serious losses, amounting to over \$1,500,000 in the same region of Illinois two years ago. Here was evidently a new and presumably an efficient method of combating the scourge if prompt action should be taken. Surely delay in making the facts known would have been reprehensible. As a matter of pure science the subject was sufficiently ripe for publication on the 29th of July as the bulletin fairly shows. T. J. BURRILL.

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A PECULIAR HAILSTORM.

DURING the past summer, while on a reconnaissance survey in southern Keewatin, for the Geological Survey of Canada, the writer's party encountered an unusual number of electric storms, particularly during the months of June and July. Quite frequently these storms were accompanied by heavy rain and hail. The heaviest of these commenced about

7:10 on the evening of July 12 and lasted about twenty minutes. As the size of the hailstones was very much larger than is usual in this part of Canada, and as the storm was accompanied by an unusual phenomenon, noted below, it seems worthy of record.

The storm approached us from the southeast, while we were near the divide between streams flowing southwest to the English River and Lake Winnipeg, and those flowing easterly towards the Cat River, a large stream, or rather a chain of lakes tributary to the Albany River. The hailstones varied from about the size of buckshot or small marbles to spheres and other forms over one inch in diameter. One large stone, in shape a compressed ovoid, measured $1.25 \times 1.75 \times 2.25$ inches. Others over 1.50 inches in diameter were plentiful. The smaller hailstones were almost invariably of clear ice with a small white nucleus of snow. The larger ones were usually white with a transparent nucleus. Many of the pellets, both small and large, were almost perfect spheres, but not infrequently the large ones took the form of disks, thin and transparent in the middle, with thicker edges of snow, reminding one of the shape of the red blood corpuscles or the fly-wheel of a sewing machine. One large pellet of this kind measured 1.75 inches in diameter and the circular rim was one inch thick, the middle portion of the disk being transparent. The disks were more often ellipsoidal than circular. The surface was generally warty or mammillated, as if produced by the coalescence of a number of independent hailstones, whereas that of the spheres and ovoids was usually smooth.

The most interesting feature accompanying the storm was the behavior of the moss carpet flooring the spruce forest everywhere. In this portion of the district this surface cover consists almost wholly of a dense mat of the moss *Hypnum triquetrum*, through which are woven a tangled mass of roots, living and dead. The thickness of the cover varies from a few inches to over a foot. During the storm there was no wind noticeable in or near the camp. The moss carpet in front of and underneath our tent was seen and felt to be heaved in

waves, the crest lines, just in front of the tent door, sometimes raising the moss as much as a foot above the normal position. These undulations traveled in the same direction as the storm was moving, *i. e.*, towards the northwest. No two crests were seen to be in existence at the same time, but the field of view was limited to an area of about thirty feet across in the direction the waves were moving. The movement began, or at least was first noticed, near the end of the hailstorm, and continued for some time after the rain and hail had ceased to fall, lasting for a period between five and ten minutes. The writer has frequently been in the moss-carpeted spruce forests of central Canada during thunder storms, but has not happened heretofore to have met a similar phenomenon. The cause of the movement seems to lie in the fact that the moss cover retained the water which first fell upon it, soaking it up like a sponge and hence became nearly air-proof. The air underneath, in the interspaces between the boulders and fallen timber upon which the moss lies, would sympathetically respond to slight variations in the barometric pressure and cause the moss to rise and fall as the pressure decreased or increased. Soon after the movement ceased many of the spaces that before contained only air were filled with water, and walking on the moss was not unlike walking on a wet sponge.

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WHAT IS NATURE STUDY?

As was stated in SCIENCE for June 20, of this year, there seem to be, among educators, many conflicting definitions in the attempt to answer the above question. Bearing on this subject the following letters have been received from eminent scientific men of this country. They appear in the order in which they were received.

W. J. BEAL.
AGRICULTURAL COLLEGE, MICH.

The present movement toward developing and spreading an interest in nature studies is one of prime importance. Our American children are, after all the efforts thus far made, woefully lacking in interest in natural